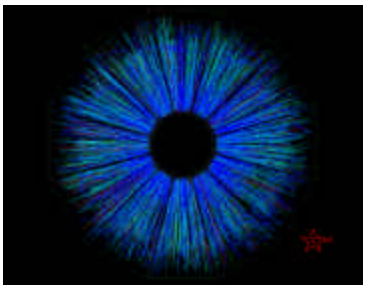
Office of Science

Nuclear Physics

http://www.sc.doe.gov/production/henp/henp.html

The Nuclear Physics program advances our knowledge of the properties and interactions of atomic nuclei and nuclear matter in terms of fundamental particles and forces. The U.S. historically has played a world leadership role in fundamental nuclear physics research. The guidance provided in the Long Range Plans of the DOE/National Science Foundation-chartered Nuclear Science Advisory Committee (NSAC) over the last two decades has been instrumental for maintaining this role. A new long range planning process will be complete in October 2001. DOE will use the scientific opportunities identified and priorities recommended in the plan to develop a forefront scientific program that will maintain the nation's leadership role.

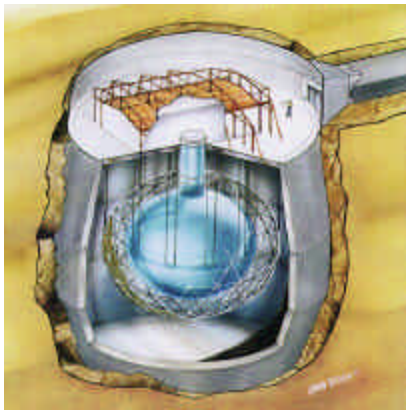
The Opportunity: A unique new nuclear physics research facility at Brookhaven National Laboratory was commissioned last fall. RHIC, the Relativistic Heavy Ion Collider will allow the study of extremely hot, dense nuclear matter. It collides beams of gold nuclei at energies sufficient to form brief microcosms of the hot, dense soup of elementary particles (quarks and gluons) that previously existed only for the first microseconds after the Big Bang origin of our universe.



Thousands of particles emerge from a collision of gold nuclei at RHIC.

Thomas Jefferson National Accelerator Facility (TJNAF), the premier facility for studying the quark structure of the nucleon, has been in operation for almost five years. This facility provides an intense polarized electron beam simultaneously to three experimental halls.

The experimental results are changing our understanding of how quarks bind together to form the fundamental building blocks of our world.



The Sudbury Neutrino Observatory in its underground cavern

The first generation of solar neutrino experiments detected fewer high-energy neutrinos than expected from our present knowledge of nuclear processes in the sun, and spawned the idea that neutrinos can change from one type to another. The currently operating Sudbury Neutrino Observatory (SNO) experiment is designed to measure for the first time the appearance of a type of neutrino that is not produced in the sun, providing revolutionary insight into the nature of neutrinos and the core of the sun.

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An exploding nebula

The Challenge: RHIC and its associated detectors have performed well, even though they still need to reach planned operating levels. The experimenters will be challenged to establish compelling evidence that quark-gluon plasma has indeed been formed by collisions of nuclei. Results from many different indications of quark gluon plasma formation must be compared and fine-tuned amongst the four major RHIC detectors.

TJNAF seen from the air

A compelling case for the outstanding scientific opportunity of RIA must be made to justify construction of this new facility for nuclear science.

Weaving together dozens of experiments in order to achieve a coherent picture of the internal structure and dynamics of protons and neutrons is a challenge for scientists at TJNAF. More than 1200 experimenters from 24 different countries come to TJNAF to perform these experiments.

FY 2002 Investment Plan: In FY 2002, the Office of Science will focus its efforts on keeping its national facilities operational and available to U.S. scientists. R&D activities for RIA will continue.

The Benefits: The Nuclear Physics program will make substantial progress toward answering three fundamental questions: what was the nature of the infant universe at the tender age of one microsecond, how is the world today constructed at its innermost level—the level of quarks inside atomic nuclei—and does the neutrino have mass? The unique DOE facilities and research program will help the United States maintain its world leadership role in nuclear physics. This fundamental physical science is a cornerstone of our strong technical economy, transferring to industry the knowledge and technology acquired in nuclear physics research and educating the nation's pool of technically trained talent.